

PATENT COOPERATION TREATY

028A

From the
INTERNATIONAL SEARCHING AUTHORITY



To:

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/EP2005/002803

International filing date (day/month/year)
16.03.2005

Priority date (day/month/year)
17.03.2004

International Patent Classification (IPC) or both national classification and IPC
G06T11/00, G06T15/00

Applicant
DEUTSCHES KREBSFORSCHUNGSZENTRUM

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/EP2005/002803

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/EP2005/002803

Box No. V Reasoned statement under Rule 43b/s.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	3,4,6-8,19,22,23,24
	No: Claims	1,2,5,9-18,20,21,25-32,33,34
Inventive step (IS)	Yes: Claims	
	No: Claims	1-34
Industrial applicability (IA)	Yes: Claims	1-34
	No: Claims	

2. Citations and explanations

see separate sheet

Reference is made to the following documents:

D1: WO 02/061686 A

D2: De Boer M et Al: "Latency- and Hazard-free Volume Memory Architecture for Direct Volume Rendering" Computers and Graphics, Pergamon Press Ltd. Oxford, GB, vol. 21, no. 2, 1 March 1997, pages 179-187, ISSN:0097-8493

D3: Kornmesser, K et Al: "Fast Feldkamp-reconstruction for real-time reconstruction using C-arm-systems" CARS 2002, Computer Assisted Radiology and Surgery, 16th International Congress and Exhibition, Paris, France, 2002, pages 430-434

1) Before discussing the characteristics of novelty and inventive step of the application, some remarks regarding **clarity** are needed.

2) It is clear from the description (see especially page 2 and also page 12 lines 18-21), that the feature of calculating the contribution of each projection to the reconstruction of the voxels is essential to the definition of the invention.

Independent apparatus **claim 1** claims merely "*multiplexing means adapted for distributing the fetched pixel data to m different pipelines*": the function of the pipelines in the claimed apparatus is not further specified, because there is no functional connection between the distribution of the data to the pipelines and the calculation of the voxel centres.

Since independent claim 1 does not contain this feature it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

The same objection apply to independent method **claim 20**, *mutatis mutandis*.

It appears, however, that a different wording of claims 1 and 20 could easily overcome this clarity objection.

3) It is not clear on which claims **dependent claim 15** is dependent on: on the one hand, it claims dependency on "*any of the above claims*", meaning claims 1 to 14, on the other hand it refers to "*m shift registers*", whereas the shift registers are mentioned only in claims 12 to 14.

The dependency should therefore be clarified (Art. 6 and R. 6.4 PCT).

- 4) Analogously, the dependency of **dependent claims 22 to 24** is not clear: they refer all to independent claim 20, but mention respectively "*the at least (2m+2) memory banks*" and "*a respective memory bank*", whereas there is no mention in claim 20 of any memory bank.
The dependency should therefore be clarified (Art. 6 and R. 6.4 PCT).
- 5) Although **claims 33 and 34** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.
- 6) Notwithstanding the above mentioned clarity remarks, the description and the drawings allow an interpretation of the claims sufficient to allow a meaningful examination of the novelty and the inventive step of the claimed subject-matter, as in the rest of this opinion reported.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability.

- 7) The subject-matter of **claim 1** is not new (Art. 33(2) PCT). In fact, document D1 discloses:
- *a backprojection unit adapted for backprojecting pixel data of n acquired projections onto a voxel subvolume comprising for each of the n projections (D1, p. 6 l. 16-19, p. 7 l. 11-18)*
 - *voxel center determination means adapted for projecting m contiguous voxels onto a respective one of the projections (D1, p. 14 l. 1-2, p. 15 l. 18-21, p. 18 l. 10);*
 - *memory access means adapted for fetching, for each of the m projected voxel centers, pixel data of pixels adjacent to the projected voxel center from a respective projection buffer (D1, p. 14 l. 1-4);*
 - *multiplexing means adapted for distributing the fetched pixel data to m different pipelines (D1, p. 6 l. 16 - p. 7 l. 5, p. 13 l. 8-14: for the selection of a particular pipeline*

a multiplexer has to be necessarily used).

Therefore, claim 1 is not new.

8) The subject-matter of **claims 2, 5 and 9 to 18 is not new** (Art. 33(2) PCT). Indeed, D1 discloses:

8.1) claim 2:

n projection buffers (D1, p. 13 l. 9-11 and Fig. 3 and 5);

8.2) claim 5:

pixel data are stored in different memory banks (D1, p. 18 l. 12-15);

8.3) claim 9:

pixel data bilinear interpolation means (D1, p. 14 l. 1-4);

8.4) claim 10:

weighting unit (D1, p. 4 l. 4-7);

8.5) claim 11:

adder unit (D1, p. 4 l. 4-7);

8.6) claim 12:

weighted pixel values are added to m different shift registers (D1, p. 14 l. 8-11);

8.7) claim 13:

voxel data are stored in m shift registers (D1, p. 13 l. 11-14);

8.8) claim 14:

each of the m shift registers comprises n storage cells (D1, p. 13 l. 11-14 and p. 19 last two lines - p. 20 l. 10);

8.9) claim 15:

the contents of the shift registers are shifted (D1, p. 14 l. 8-11);

- 8.10) claim 16:
the voxel subvolume is a slice (D1, p. 17 l. 18-21);
- 8.11) claim 17:
the slices are oriented perpendicular to an axis of rotation (D1, p. 17 l. 14-21 and Fig. 10);
- 8.12) claim 18:
each voxel subvolume is a slice of a respective column (D1, p. 17 l. 21-23 and Fig. 11: each "Voxelwürfel 17" correspond to a subdivision in columns);

Inventive step

9) The subject-matter of **claims 3 and 4 is not inventive** (Art. 33(3) PCT).

9.1) In fact, document D1 which is considered to represent the closest prior art, discloses all the features of claim 2 (see 8.1 above) on which claim 3 is dependent and additionally to these discloses that each projection buffer comprises several memory banks (D1, p. 18 l. 10-15).

The backprojection unit of claim 3 differs from the one disclosed in D1 in that each projection buffer comprises at least $(2m+2)$ different memory banks.

The mere fact that the banks are $(2m+2)$ cannot be seen to make any contribution to the solution of a technical problem: in fact, the function of such a particular number of memory banks is not claimed in any way.

Therefore, the subject-matter of claim 3 is not inventive.

9.2) Further, document D1 discloses that the whole backprojection process is performed in parallel on many projections at the same time (D1, p. 7 l. 11-13), whereas the projections are stored in several memory banks (see 9.1 above).

The difference of claim 4 from the disclosure in D1 is therefore the same as for claim 3, i.e. that the memory banks are $(2m+2)$.

For the reasons explained at point 9.1. above, the subject-matter of claim 4 is therefore not inventive.

- 10) The subject-matter of **claims 6 to 8 is not inventive** (Art. 33(3) PCT). In fact, considering document D1 as representing the closest prior art, the difference of the claimed subject-matter from the disclosure in D1 is the particular way of addressing pixels in the memory banks, i.e. a memory bank where a pixel is stored in is selected by means of a two-dimensional (u, v) index derived from the pixel coordinates (x, y) , whereas for $m=4$, $(u, v) = (x \bmod 5, y \bmod 2)$.
This particular way of addressing allows to store the adjacent elements of a data structure (as the pixels of the projection data, in this case) into different memory banks, so that one is able to access each single item from a different memory bank.
This technique is called "data interleaving", and is used in the art in particular for parallel access, as document D2 discloses (D2, p. 181 right col. l. 6-14 and Fig. 3). In such technique, the use of the "mod" function to calculate the correct bank is directly linked to the periodic nature of the assignment, that means that the system of document D2 necessarily makes use of the modulus function to cycle over the banks to assign the data.
Therefore, to save the pixels in an "interleaved" way, the skilled person would combine the selection system of D2 with the backprojection unit of D1 without the exercise of an inventive step to obtain the claimed subject-matter.
Therefore, the subject-matter of claims 6 to 8 is not inventive.
- 11) The subject-matter of **claim 19 is not inventive** (Art. 33(3) PCT). In fact, claim 19 differs from D1, regarded as representing the closest prior art, in that the claimed unit is implemented by means of a Field Programmable Gate Array (FPGA). Document D3 discloses the use of FPGA based hardware for the implementation of backprojection units (D3, abstract).
Therefore, the skilled person would regard the use of an FPGA to implement the unit of D1 as a normal design option, obtaining in this way the same unit as claimed in claim 19 without the exercise of an inventive step.
- 12) The above statements apply to the corresponding method **claims 20 to 32** and computer program product **claims 33 and 34**, mutatis mutandis.

PATENT COOPERATION TREATY

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Applicant
DEUTSCHES KREBSFORSCHUNGSZENTRUM

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- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
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3. For further details, see notes to Form PCT/ISA/220.

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/EP2005/002803

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
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 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/EP2005/002803

Box No. V Reasoned statement under Rule 43b/s.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	3,4,6-8,19,22,23,24
	No: Claims	1,2,5,9-18,20,21,25-32,33,34
Inventive step (IS)	Yes: Claims	
	No: Claims	1-34
Industrial applicability (IA)	Yes: Claims	1-34
	No: Claims	

2. Citations and explanations

see separate sheet

Reference is made to the following documents:

D1: WO 02/061686 A

D2: De Boer M et Al: "Latency- and Hazard-free Volume Memory Architecture for Direct Volume Rendering" Computers and Graphics, Pergamon Press Ltd. Oxford, GB, vol. 21, no. 2, 1 March 1997, pages 179-187, ISSN:0097-8493.

D3: Kornmesser, K et Al: "Fast Feldkamp-reconstruction for real-time reconstruction using C-arm-systems" CARS 2002, Computer Assisted Radiology and Surgery, 16th International Congress and Exhibition, Paris, France, 2002, pages 430-434

1) Before discussing the characteristics of novelty and inventive step of the application, some remarks regarding **clarity** are needed.

2) It is clear from the description (see especially page 2 and also page 12 lines 18-21), that the feature of calculating the contribution of each projection to the reconstruction of the voxels is essential to the definition of the invention.

Independent apparatus **claim 1** claims merely "*multiplexing means adapted for distributing the fetched pixel data to m different pipelines*": the function of the pipelines in the claimed apparatus is not further specified, because there is no functional connection between the distribution of the data to the pipelines and the calculation of the voxel centres.

Since independent claim 1 does not contain this feature it does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT that any independent claim must contain all the technical features essential to the definition of the invention.

The same objection apply to independent method **claim 20**, mutatis mutandis.

It appears, however, that a different wording of claims 1 and 20 could easily overcome this clarity objection.

3) It is not clear on which claims **dependent claim 15** is dependent on: on the one hand, it claims dependency on "*any of the above claims*", meaning claims 1 to 14, on the other hand it refers to "*m shift registers*", whereas the shift registers are mentioned only in claims 12 to 14.

The dependency should therefore be clarified (Art. 6 and R. 6.4 PCT).

- 4) Analogously, the dependency of **dependent claims 22 to 24** is not clear: they refer all to independent claim 20, but mention respectively "*the at least (2m+2) memory banks*" and "*a respective memory bank*", whereas there is no mention in claim 20 of any memory bank.
The dependency should therefore be clarified (Art. 6 and R. 6.4 PCT).
- 5) Although **claims 33 and 34** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.
- 6) Notwithstanding the above mentioned clarity remarks, the description and the drawings allow an interpretation of the claims sufficient to allow a meaningful examination of the novelty and the inventive step of the claimed subject-matter, as in the rest of this opinion reported.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability.

- 7) The subject-matter of **claim 1** is not new (Art. 33(2) PCT). In fact, document D1 discloses:
- *a backprojection unit adapted for backprojecting pixel data of n acquired projections onto a voxel subvolume comprising for each of the n projections (D1, p. 6 l. 16-19, p. 7 l. 11-18)*
 - *voxel center determination means adapted for projecting m contiguous voxels onto a respective one of the projections (D1, p. 14 l. 1-2, p. 15 l. 18-21, p. 18 l. 10);*
 - *memory access means adapted for fetching, for each of the m projected voxel centers, pixel data of pixels adjacent to the projected voxel center from a respective projection buffer (D1, p. 14 l. 1-4);*
 - *multiplexing means adapted for distributing the fetched pixel data to m different pipelines (D1, p. 6 l. 16 - p. 7 l. 5, p. 13 l. 8-14; for the selection of a particular pipeline*

a multiplexer has to be necessarily used).

Therefore, claim 1 is not new.

8) The subject-matter of **claims 2, 5 and 9 to 18 is not new** (Art. 33(2) PCT). Indeed, D1 discloses:

8.1) claim 2:

n projection buffers (D1, p. 13 l. 9-11 and Fig. 3 and 5);

8.2) claim 5:

pixel data are stored in different memory banks (D1, p. 18 l. 12-15);

8.3) claim 9:

pixel data bilinear interpolation means (D1, p. 14 l. 1-4);

8.4) claim 10:

weighting unit (D1, p. 4 l. 4-7);

8.5) claim 11:

adder unit (D1, p. 4 l. 4-7);

8.6) claim 12:

weighted pixel values are added to m different shift registers (D1, p. 14 l. 8-11);

8.7) claim 13:

voxel data are stored in m shift registers (D1, p. 13 l. 11-14);

8.8) claim 14:

each of the m shift registers comprises n storage cells (D1, p. 13 l. 11-14 and p. 19 last two lines - p. 20 l. 10);

8.9) claim 15:

the contents of the shift registers are shifted (D1, p. 14 l. 8-11);

- 8.10) claim 16:
the voxel subvolume is a slice (D1, p. 17 l. 18-21);
- 8.11) claim 17:
the slices are oriented perpendicular to an axis of rotation (D1, p. 17 l. 14-21 and Fig. 10);
- 8.12) claim 18:
each voxel subvolume is a slice of a respective column (D1, p. 17 l. 21-23 and Fig. 11: each "Voxelwürfel 17" correspond to a subdivision in columns);

Inventive step

9) The subject-matter of **claims 3 and 4 is not inventive** (Art. 33(3) PCT).

9.1) In fact, document D1 which is considered to represent the closest prior art, discloses all the features of claim 2 (see 8.1 above) on which claim 3 is dependent and additionally to these discloses that each projection buffer comprises several memory banks (D1, p. 18 l. 10-15).

The backprojection unit of claim 3 differs from the one disclosed in D1 in that each projection buffer comprises at least $(2m+2)$ different memory banks.

The mere fact that the banks are $(2m+2)$ cannot be seen to make any contribution to the solution of a technical problem: in fact, the function of such a particular number of memory banks is not claimed in any way.

Therefore, the subject-matter of claim 3 is not inventive.

9.2) Further, document D1 discloses that the whole backprojection process is performed in parallel on many projections at the same time (D1, p. 7 l. 11-13), whereas the projections are stored in several memory banks (see 9.1 above).

The difference of claim 4 from the disclosure in D1 is therefore the same as for claim 3, i.e. that the memory banks are $(2m+2)$.

For the reasons explained at point 9.1. above, the subject-matter of claim 4 is therefore not inventive.

- 10) The subject-matter of **claims 6 to 8 is not inventive** (Art. 33(3) PCT). In fact, considering document D1 as representing the closest prior art, the difference of the claimed subject-matter from the disclosure in D1 is the particular way of addressing pixels in the memory banks, i.e. a memory bank where a pixel is stored in is selected by means of a two-dimensional (u, v) index derived from the pixel coordinates (x, y) , whereas for $m=4$, $(u, v) = (x \bmod 5, y \bmod 2)$.
This particular way of addressing allows to store the adjacent elements of a data structure (as the pixels of the projection data, in this case) into different memory banks, so that one is able to access each single item from a different memory bank.
This technique is called "data interleaving", and is used in the art in particular for parallel access, as document D2 discloses (D2, p. 181 right col. l. 6-14 and Fig. 3). In such technique, the use of the "mod" function to calculate the correct bank is directly linked to the periodic nature of the assignment, that means that the system of document D2 necessarily makes use of the modulus function to cycle over the banks to assign the data.
Therefore, to save the pixels in an "interleaved" way, the skilled person would combine the selection system of D2 with the backprojection unit of D1 without the exercise of an inventive step to obtain the claimed subject-matter.
Therefore, the subject-matter of claims 6 to 8 is not inventive.
- 11) The subject-matter of **claim 19 is not inventive** (Art. 33(3) PCT). In fact, claim 19 differs from D1, regarded as representing the closest prior art, in that the claimed unit is implemented by means of a Field Programmable Gate Array (FPGA). Document D3 discloses the use of FPGA based hardware for the implementation of backprojection units (D3, abstract).
Therefore, the skilled person would regard the use of an FPGA to implement the unit of D1 as a normal design option, obtaining in this way the same unit as claimed in claim 19 without the exercise of an inventive step.
- 12) The above statements apply to the corresponding method **claims 20 to 32** and computer program product **claims 33 and 34**, mutatis mutandis.